Methodological proposal for teamwork evaluation in the field of project management training

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Abstract

Teamwork is one of the abilities that today is highly valued in the professional arena with a great importance for various personal and interpersonal skills associated with it. In this context, the Technical University of Madrid, is developing a coordinated educational innovation project, which main objective is to develop methodological and assessment tools for the acquisition of personal skills necessary to improve the employability of graduates and their skills for project management. Within this context, this paper proposes a methodology composed of various activities and indicators, as well as specific assessment instruments linked to the teamwork competence. Through a series of systematic steps it was allowed the design of an instrument and construction of a scale for measuring the competence of teamwork. The practical application of the methodology has been carried out in Projects lectures from different Schools of Engineering at the Technical University of Madrid, which results are presented in this document as a pilot experience. Results show the various aspects and methods that teachers should consider in evaluating the competence of the work, including analysis of the quality of results, through reliability and construct validity. On the other hand, show the advantages of applying this methodology in the field of project management teaching.

Keywords: Competence, Project Management, Teamwork, Leadership

1. Introduction

The Technical University of Madrid (UPM) have developed the Educational Innovation Project (PIE) with the aim of designing instruments to guide and facilitate the teaching and development and evaluation of generic competencies , at undergraduate and graduate level, adapted from the European Higher Education Area (EHEA) in order for students to obtain and develop a range of skills to seek with a direct link of university education with professional practice looking to broad students employability.

Within this context teamwork is highlighted of utmost importance for the achievement of a better employability, as well as highly valued for professional performance, as Guitert argues(2007: 2) tells "we cannot forget the importance given from the EHEA to teamwork from two approaches: firstly, as a methodology that encourages the student to perform work processes in an active and participatory way and, secondly, because teamwork is currently one of the most valued skills in professional backgrounds. "

OECD defines competence as "the ability to respond to the demands or carry out tasks successfully" (OECD, 2005:4). This concept of refers to attitudes, abilities skills, and performance abilities. As can be seen, the concept of

competence includes knowledge, know-how and knowledge to be, so people acquire and develop skills to foster their development as individuals and as professionals.
Thus teamwork competence refers to a set of actions, strategies, procedures and methodologies used by a group of people to achieve objectives and / or goals, sharing responsibilities. Teamwork involves groups creation where people meet, collaborate and interact specifically for a particular purpose (work or project), covering three main lines of action: team building, teamwork and group dynamics.
At this point it is important to note that teamwork is not the same as teams, which Carillo (2007) defined as a set of individuals assigned or self-assigned according to specific skills and competences to meet a given target under the management of a coordinator. Thus, teamwork is to know how to interact with others on an individual basis, providing their personal resources to achieve common goals.
The interaction among people within teamwork is what motivates the existence of relationships between behavioral competences, especially leadership and negotiation, have been highlighted in numerous investigations in the academic field and business research (Keller, 1992, Kendra and Taplin, 2004, Turner and Muller, 2005, Cano et al, 2008; Yang et al, 2011).

2. Teaching Estategy

The strategy is part of the actions taken by the Technical University of Madrid to encourage educational innovation and renewal of university teaching as a strategic line of action for all technical schools from the university (UPM, 2006). The General Quality of Teaching Plan establishes as center line for innovation actions the "Educational Innovation Groups" (GIEs) as an original bet in the current university cene. One of these group, known as GIE-Project, gathers a group of people with a history, experience, training and a future project of sufficient consistency in the field of engineering projects (UPM, 2006). GIE-Project was founded in 2005, with the objective of designing a new learning dimension based on educational projects suitable for generating an early professional experience and training in skills for project management. After six years of joint work among its members, GIE-Project was established as a basic unit of stable cooperation for promotion and development of Educational Innovation (De los Rios et al 2009). Its creation is part of the overall strategy of empowerment of Educational Innovation at the UPM **and since 2008 in the " UPM main line of formation" (UPM, 2008).** The teaching strategy developed by GIE-Project build its basis on the Project-Based Learning, gathered over twenty years of experience (De los Rios et al, 2010) in the Projects lecture at the late formation of undergraduates.
The Project-Based Learning (PBL) foundations have been described in numerous researches (Chinnowsky et al., 2006; Gijselaers, 1996; Johnson, 1999; Padmanadhan and Katti, 2002, De los Rios et al, 2010, 2011), showing that is the best means to achieve effective skills-based education (Parsons et al., 2005, Mulcahy, 2000; Kelly, 2007) integrating knowledge, skills and values.
The methodology proposed for this experience is supported on collective learning processes so that students are not passive recipients of knowledge (Chinnowsky et al., 2006). The methodology is based on building new knowledge from existing knowledge base (Gijselaers, 1996), through active participation and interaction with others.
The basis of the teaching methodology is that students get together in small teams plan, design and evaluate a project that meets a real need raised by an external client, coordinated by the teacher of the Project lecture. This learning process, described on other articles (De los Rios et al, 2010), requires the use of various information sources and disciplines by students needed to solve specific problems.

3. Methodology

The methodology for teamwork evaluation includes the following activities within the course: i) a continuous students assessment on activities development and behaviors towards teamwork development, ii) behavior assessment between teammates through a 360-degree assessment, iii) a self-assessment of their knowledge and experience on the competence base of Project Management IPMA-AEIPRO iv) a questionnaire about their participation in the course project and skills development related to teamwork.
The methodology was applied in 2010-11, to a total of 73 students enrolled in the Projects Lecture of Engineering at two schools at the UPM (Agronomists and Industry). The self-assessment tools were made through Moodle (Virtual Platform of the UPM) and participants who left unanswered questions in the second instrument were eliminated.

3.1 Instruments

For this methodology were used two instruments: a self-assessment survey and a questionnaire on skills for teamwork. Both instruments used a Likert scale (Likert, 1932), commonly used in social sciences to assess perceptions and qualitative aspects and whose main purpose is to stagger individuals (Barber, 1993). Thus the main

objective of staggering is to determine the value of a variable as accurately as possible, seeking thereby its usefulness and therefore its quality (Oviedo and Fields-Arias, 2005).

Questionnaire 1: self-assessment skills.

It was implemented a self-assessment survey at the beginning and end of the academic period. The instrument was designed based on the tool used by IPMA for the evaluation and certification of competencies in Project Management (IPMA, 2009), which includes 92 items-46 on knowledge of competition and 46 on experience-, covering three areas of competence: technical elements -20, 11contextual and 15 of professional behavior according to the baseline from the Project Management Competence from IPMA (NCB-IPMA AEIPRO version 3.1). A Likert scale of four points was used. For the knowledge scale is: (4) well, (3) normal, (2) something (1) nothing; and for experience is: (4) always, (3) often, (2) once and (1) I have not applied. For the results descriptive analysis, the level of competence development was assessed scaled in four levels, according to the following table:

Value scale for level of competence development for questionnaire nº 1.

Level	Average	Characteristics
High	Between 4.0 y 5.0	Has much knowledge
Medium high	Between 3.0 y 3.9	Has quite knowledge
Low average	Between 2.0 y 2.9	Has some knowledge
Low	Between 1.0 y 1.9	Has few knowledge

Questionnaire 2: skills for teamwork.- This tool was originally designed with 61 questions related to student participation (working together) in the course project and the skills development associated with teamwork. This questionnaire was developed by the UPM team based on different variables used in previous studies (Ainley, 2001; Ginns and Ellis, 2007; Kember and Leung, 2009, Muller and Turner, 2007; Bassand Avolio, 1990, Arribas and Pereña, 2009), applying a Likert scale of four levels: strongly agree (5), Agree(4), Any (3), Disagree (2) and Strongly Disagree (1). This questionnaire was applied at the end of the course and level of competence development was scaled as follow:

Value scale for level of competence development for questionnaire nº 2.

Level	Average	Characteristics
High	Between 4.0 y 5.0	Strong competence development
Medium high	Between 3.0 y 3.9	Enough competence development
Low average	Between 2.0 y 2.9	Some competence development
Low	Between 1.0 y 1.9	Scarce competence development

3.1.1 Instruments Psychometric properties

In order to validate the psychometric properties of the instruments two processes were carried out: a) analysis of the reliability using internal consistency coefficient Cronbach's Alpha, and b) analysis of construct validity, estimated through factor analysis. The reliability and validity are interdependent concepts, but not equivalent. An instrument can be consistent, but not valid, hence the two properties should be assessed simultaneously whenever possible (Morgan et al. Al., 2001, Nelson-Gray, 1991). Yela (1996) state that is also necessary to have scales that is to have normative values of the population with which to compare the score or outcome of an individual.

a) Reliability Analysis

Reliability is not a feature of the instrument, but from the results obtained in a given sample (Morales, 2008). Nunnally (1978) proposes a minimum of 0.700 and some authors claim that reliabilities of less than 0.600 are not suitable for making decisions about individuals and is questionable for the description of a group or research in general (Guilford, 1954, Pfeiffer et. al., 1976).

Questionnaire 1: self-assessment skills .-

Because this self-assessment questionnaire designed by IPMA is being used as a reference tool in the evaluation and certification of skills in project management, there was no need to validate it. Nontheless a reliability analysis of the students responses through the Cronbach alpha coefficient was conducted, which results were very acceptable, as shown in the table below.

Internal Consistency Results Questionnaire 1

Self Assesment	Items	Cronbach Alpha
Initial Knowledge	46	0.963
Initial Experience	46	0.966
Final Knowledge	46	0.958
Final Experience	46	0.945

Questionnaire 2: skills for teamwork. Firstly, was conducted to analyze the reliability of the instrument with 61 items through the Cronbach alpha coefficient, with the following results:

Internal Consistency Results Questionnaire 2

Competence	Items	Cronbach Alpha	Cronbach Alpha i fan item is deleted
Communication	5	0.316	0. 511 (item 3)
Conflict and Crisis	3	0.592	
Creativity and Innovation	8	0.705	0.765 (item 11)
Leadership	15	0.848	
Negotiation	9	0.709	0.712 (item 32)
Planning	2	0.468	
Teamwork	19	0.863	0.864 (item 53)
Total	61	0.938	

As can be seen, reliabilities were found below 0,700, due to the small number of items composing the factor (Nunnally & Bernstein, 1994). So that as a first step we remove the items under the competences of communication, conflict and crisis, planning for low reliability, and item 11 which thus allows us to improve the reliability of creativity, item 32 and 53 are left out for not contributing much improvement in the reliability of their competence as shown in the table above , in order to stay with a questionnaire of 50 items and a Cronbach alpha reliability of 0,933.

b) Construct validity

As previously mentioned questionnaire No. 1 -designed by IPMA-is a validated instrument used by IPMA in the process of Project Management competence assessment and certification (IPMA, 2009), hence did not require validation.

Regarding questionnaire No. 2, consisting of 50 items, was processed in order to validate construct as a unifying concept that integrates considerations of content and criterion validity in a common framework to test hypotheses about relationships theoretically relevant (Messick, 1980: 1015). The validity of a construct occurs when all **designed measures to evaluate show factor consistency when subjected to factor analysis (Muñiz, 1998).** Applying this technique of factor analysis (FA) is possible to reduce variables and group them according to their dimensions in common factors. The FA has two types: Exploratory Factor Analysis (EFA) and confirmatory factor analysis (CFA), and the most important difference lies in that CFA is driven by substantive theories and expectations, while the EFA, as its name implies, is a technique based on data, trying to uncover the underlying structure that they have (Bollen, 1989). To process the EFA EFA FACTOR software was used (Lorenzo-Seva & Ferrando, 2006), which analyzes the matrix by means of a polychoric correlation, determining the number of factors by MAP procedure, Minimum Average Partial Test (Velicer, 1976), factorization method MINRAD and PAF (minimum waste). Finally, to identify factors varimax rotation was used (Bentler, 1977). Two factors are assumed.

Results of Factor Analysis by MAP procedure,with subsequent VARIMAX rotation.

Item	F1	Item	F2
10	0.498	9	0.506
20	0.518	13	0.405
32	0.629	14	0.611
43	0.411	15	0.464
44	0.618	16	0.655
45	0.398	18	0.512
46	0.590	19	0.513
47	0.463	21	0.672

48	0.616	22	0.471
49	0.484	23	0.487
50	0.312	24	0.629
51	0.586	25	0.505
52	0.611	27	0.670
54	0.398	28	0.452
55	0.716	29	0.444
56	0.557	30	0.465
58	0.473	31	0.468
59	0.484	34	0.549
61	0.430	35	0.422
		36	0.527
		37	0.513
		38	0.524
		40	0.422
		53	0.430
		57	0.416
		60	0.315

In the first factor, F1 "Teamwork" - are clustered items related to "teamwork" competence within the course project. The second factor, F2, was called "teamwork support skills ", bringing together other items related to the development of other abilities such as leadership, creativity and negotiation, which are necessary to develop good team work within a project (Keller, 1992; Kendra and Taplin, 2004; Turner and Muller, 2005; Yanga et al, 2011).
After performing the analysis it was decided to discard items 12, 33 and 39 - due to its low rating factor (of 0,300) after VARIMAX rotation (Lorenzo-Seva, 2003). Other items, 17 and 26 - were dismissed by not measuring the same construct within factor 1. Thus, the final instrument, after treatment, was left with 45 items, giving a reliability of 0.930. Can also be observed the reliability for factor 1 **"teamwork" with 19** items was 0,910, and factor 2 "skills to support teamwork," with 26 items has a reliability of 0.883, which are very acceptable. The final questionnaire can be seen in Annex 01.

4. Results

4.1 Project Management Competence Development (Self Assessment)
Results show that students, through teamwork and through the project-based learning methodology, improve knowledge in three project management skills areas technical, contextual and behavioral. Similarly, in terms of experience in skills application, results evidenced that student group improved implementation of competence throughout the project, from a medium-low to medium-high level. The table below show the overall results obtained in the three areas of skills, both as knowledge and experience.

Competence area	KNOWLEDGE			EXPERIENCE		
	SCALE	INITIAL (%)	FINAL (%)	SCALE	INITIAL (%)	FINAL (%)
Technical	High	11.70	38.60	(4) Always	11.60	32.30
	Medium High	49.60	50.20	(3) Frequently	38.20	52.80
	Medium Low	30.80	10.60	(2) Sometime	35.70	14.20
	Low	7.90	0.60	(1) Never applied	14.50	0.80
Behaviour	High	26.50	46.80	(4) Always	25.90	41.80
	Medium High	51.80	48.00	(3) Frequently	45.50	50.40
	Medium Low	19.20	5.00	(2) Sometime	26.60	7.40
	Low	2.50	0.20	(1) Never applied	4.00	0.40
Contextual	High	8.80	20.80	(4) Always	7.20	14.20
	Medium High	36.10	54.40	(3) Frequently	26.70	52.40
	Medium Low	39.50	24.40	(2) Sometime	42.10	29.90
	Low	15.60	2.40	(1) Never applied	24.00	3.50

4.2. Teamwork skills development

In relation to the teamwork competence, it appears that at the group level (93% of students) had a high competence development with a rating of 4.4. This development means that most of the population, after participation in the activities developed other skills and behaviors. These skills, related to teamwork, obtained high values: Creativity (4.3), Leadership (4.1) and Negotiation (4.0). It is evidenced the strong relation of teamwork success, with the development of other skills.

After application of the questionnaire shows that at the group level, 46% of students said that to agree and 41% strongly agree to have developed a set of skills associated with teamwork (creativity, leadership, negotiation) within project activities.

One of the most valued -by 82% of the participants- was the development of creativity as team activities have been considered an important element in improving their abilities to think and act in an original and imaginative way to face the challenges of the project .Teamwork has been a trigger to exploit the collective creativity of all team members. These results agree in considering creativity as a core competence for the project success (IPMA, 2009), helping to overcome problems and motivate the team to work together to develop creative ideas and turn them into operational solutions. In this sense, teams developed different methods such as sessions brainstorming.

Secondly, 79% of students show the development of negotiation. Teamwork has been a means by which members have been able to resolve disagreements between them, to find solutions satisfactory to all. This capability has allowed negotiation from reasoning, listening to the point of view of others and to exchange views resolving actual conflicts generated in project teams.

Finally, in 61% of the pupils evidenced the development of another competence for project management: leadership. This competence has not only been developed by the teams coordinators (project managers), but also other members have also succeed to provide direction and motivation to other colleagues in their work to help meet the projects´ objectives. This competition has been worked throughout all phases of the project, being of particular importance when the teams have met with problems and uncertainties. Some team members have begun to be seen themselves as a true leader when presenting the project to other teams and teachers. The overall results are shown in the table below.

Competence	Items	Scale	Frequency (%)
Teamwork	19	(5) Totally agree	48.2
		(4) Agree	44.1
		(3) Indifferent	6.0
		(2) Disagree	1.2
		(1) Totally disagree	0.5
Creativity	5	(5) Totally agree	41.9
		(4) Agree	47.1
		(3) Indifferent	9.6
		(2) Disagree	1.4
		(1) Totally disagree	0
Leadership	15	(5) Totally agree	35.5
		(4) Agree	46.4
		(3) Indifferent	15.0
		(2) Disagree	2.6
		(1) Totally disagree	0.50
Negotiation	6	(5) Totally agree	29.2
		(4) Agree	50.2
		(3) Indifferent	16.1
		(2) Disagree	2.7
		(1) Totally disagree	1.8
Overall (4)	45	(5) Totally agree	40.7
		(4) Agree	46.0
		(3) Indifferent	10.7
		(2) Disagree	1.9
		(1) Totally disagree	0.7

Finally, results obtained from the two questionnaires were developed on individual reports for 73 students, informing them of their skills development.

5. Conclusions

Experience described and the instruments used are integrated as part of a methodology for Project Based Learning (PBL), shown as an educational methodology very suitable for the skills development, linking teaching with the professional environment. The teamwork evaluation methodology is based on cooperation, active participation and interaction, offering multiple possibilities for the development of technical, contextual and behavioral competences.

Experience shows, as a first conclusion, that the success of a learning process focused on teamwork, requires that both teachers and students take an active role, a shared commitment and, in the case of students greater responsibility for their own learning. Best results are related to students participating actively, sharing information, knowledge and experience, performing assigned tasks and meeting the required deadlines, as well as maintaining collaborative relationships with their peers, showing willingness to help and involved in contributing ideas, making decisions together-, foster team spirit and cohesion, allowing the integration of ideas alien to yours - and improve the functioning of the equipment itself, with the resolution problems, agreements negotiation and proposing ideas to improve the team and the project.

Secondly, the development of teamwork competence, from the scientific basis of PBL, generates processes of learning where students are immersed in an experience of cooperation to help develop other personal skills, strengthening leadership, creativity, negotiation, and bringing students closer to the real world of project management. Leadership involves providing direction and motivation to others in their role or task to fulfill the objectives of a project, the creativity and the capacity to think and act in an original and imaginative, exploiting individual and collective ideas to find common benefits in the project; negotiation as the means by which people can resolve their disagreements, maintaining good relations within the project team (IPMA, 2009). These personal skills have proven critical in teamwork (Keller, 1992, Kendra and Taplin, 2004, Turner and Muller, 2005, Yang et al, 2011). This encourages the innovative spirit and creative ability to generate new knowledge, thinking productively, and increase their motivation and enthusiasm to learn and solve problems together. The assessment tools developed highlight the potential of teamwork, with cooperative models Project Based Learning, in order to improve the university teaching strategies and open new areas for cooperation and educational innovation.

Finally we can argue that the competence approach should be used by establishing connections with the professional world. Competences - technical, personal and contextual- for project management allows linking training from the university and professional certification systems giving stronger projection to future graduates.

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ANNEX
Final Questionnaire Teamwork Competences

Item	Question
1	My participation on this project has allow me to improve my capacity to generate ideas
2	**…has increased my effort to learn how my teammates work**
3	**…has encourage me to develop curiosity to know things that are around me**
4	**… has taught me to take the lead in establishing relationships with others.**
5	... has helped me deal with difficult situations and challenges to overcome.
6	Participation in the project has helped me make decisions to difficult problems.
7	Participation in the project has helped me learn to mediate to solve the problems of others.
8	Participation in the project has helped me to play a major role in teamwork.
9	Participation in the project has helped me to know how to delegate certain tasks to other team members.
10	By participating in the project I discovered that I like to assume greater responsibilities.
11	The participation in the project has helped me to guide my colleagues into their activities.
12	The participation in the project has helped me to take responsibility and make decisions.
13	... I discovered that I am a reference for others in the performance of certain activities.
14	.. I have awakened interest in instructing others to do the job, set goals and make decisions.
15	... have improved self-control to deal with daily work, with a disciplined and orderly approach.
16	.. Helped me to discuss workplace issues through debate and consensus with others.
17	... I have improved my leadership, influencing the actions of others effectively.
18	... I have provided direction and motivation to others in their tasks and problem solving.
19	The participation in the project has helped me to have a clear idea of things and express them clearly.
20	... I have learned to consult with other team members and to consider their proposals and opinions.
21	With my involvement in the project I have developed my ability to negotiate and reach agreements.
22	T he participation in the project has taught me to intervene in the conflicts that arise between partners.
23	The participation in the project has helped me discover that I can if I intend to convince anyone of anything.
24	The participation in the project has taught me to successfully complete the business they undertake.
25	... I discovered that I am a suitable person to successfully solve a complicated negotiation.
26	The participation in the project has confirmed to me that I am able to defend or argue any point of view.
27	With my involvement in the project have increased my responsibility to take personal and collective tasks.
28	The participation in the project has taught me to participate in groups designed to achieve common goals.
29	The participation in the project has helped me to trust people.
30	... has helped me to understand how my personal actions affect the progress of my team.
31	... has helped me to put more emphasis on values and management style practiced in my team.
32	The participation in the project has helped me confirm that it is worth working on a computer like mine.
33	The participation in the project has helped me be clear on what are the main objectives of my team.
34	... has helped me become more aware of the effects of my actions on others.
35	... has helped me discover that I need my job allows me to develop my skills and express my views.
36	The participation in the project has helped me become more aware of the challenges that affect my team.
37	The participation in the project has increased my commitment to the people associated with the project.
38	With my participation in the project I learned to share efforts and collective tasks to get results.
39	With my involvement in the project objectives have learned to notice in the daily work to achieve the objectives.
40	With my participation in the project I learned to work together and collaborate proactively.
41	The participation in the project has helped me to consider the level of performance and capabilities of my colleagues.
42	The participation in the project has helped me to discover that people like to work with me as a team.
43	The participation in the project has helped me confirm that the result of a working group is better than the sum of individual results.
44	The participation in the project has helped me to improve relations with each of my companions.
45	The participation in the project has helped me to feel responsible for the successes and failures of my team